Larson Design Group ®

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# CNG 101

CNG FOCUS GROUP

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# Presentation Outline

- Introduction
- Safety First
- CNG 101
- Best Vehicle Prospects
- CNG Fueling Stations
- NGV Economics

# Key to slides

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- Blue Background Slides - From NGVAmerica/Clean Vehicle Education Foundation – key trade organizations
- Orange Bordered Slides – Trillium, a CNG service provider
- Yellow – Larson Design Group/CNG Focus Group

# Main compression and building code sources

- NFPA 30A – Code for Motor Fuel Dispensing Facilities and Repair Garages
- NFPA  52 – Vehicular Gaseous Fuel Systems Code
- NFPA 70 – National Electrical Code
- International Fire Code
- Local Authority Having Jurisdiction (AHJ)
  - Fire Marshal

# CNG 101

CNG = Compressed Natural Gas

It is composed of methane ($CH_4$) and compressed to less than 1% of the volume it occupies at standard atmospheric pressure. It is stored and distributed into vehicle pressure vessels…in the US, the new standard fill pressure is 3600psi.

NGV = Natural Gas Vehicle

# Vehicular Natural Gas: Types and Uses

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# Types of Vehicular Natural Gas

## Liquefied Natural Gas (LNG)

- Cryogenically cooled to liquid @ ~(260)F, stored in liquid form onboard vehicle and vaporized before it enters engine cylinder
- Preferred by many heavy-duty fleets due to its energy density, space requirements

- Most vehicular LNG used today is produced at limited number of plants and trucked to fleets' onsite storage vessels. Transport distance/costs are major determinant of economic feasibility


- Another application for LNG is L/CNG stations which dispense LNG (e.g., for OTR truck fleets) and provide additional option to compress LNG and flash evaporate to provide CNG. This is a potential option for locations where there may be no pipeline supply of natural gas

# Types of Vehicular Natural Gas

## Compressed Natural Gas (CNG)

- Gas delivered to site by local gas utility and compressed and stored on site and/or distributed directly to vehicles

- Onboard 3600psi vehicle cylinders; 4 types of onboard cylinders; all meet same safety standard.
  - Type I (all metal)
  - Type II (metal liner, partial wrap)
  - Type III (metal liner, full wrap)
  - Type IV (plastic liner, full wrap)


- Burst designed to 2.5X fill psi; PRDs set far below this level

# *Key Attributes and Best Prospects*


- High fuel use vehicles with return-to-base operations or repetitive route or pre-set geographic operating areas
- LTL freight truck – 16-30K GGE
  Transit buses – 12.5-15K GGE
  Refuse trucks – 7.5-10K GGE
  Municipal sweeper – 5-6K GGE
  Airport shuttle service – 5.5-7.5K GGE
  F&B, Textile Svcs, Household Goods – 3-5K GGE
  Taxi - 4.5-5.5K GGE
  School Bus – 2-3K GGE
  Courier sedan, newspaper van, utility/ telecom van, PWD and E&P pick-ups – 1.5K GGE
- Consumer market tends to follow infrastructure*

# 4 COMPONENTS OF A CNG STATION

> Gas Dryer

> Compressor

> Storage Vessels

> Dispenser

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Gas Dryer


Compressor


Storage Vessels


Dispenser

# UPS Los Angeles
# High capacity commercial CNG station


Trillium
Making CNG Work for You.

# Fill’er Up

Natural Gas Fuel Station Types

Development, Ownership and Operations Options

Sizing/Design Considerations

# CNG Fuel Station Types

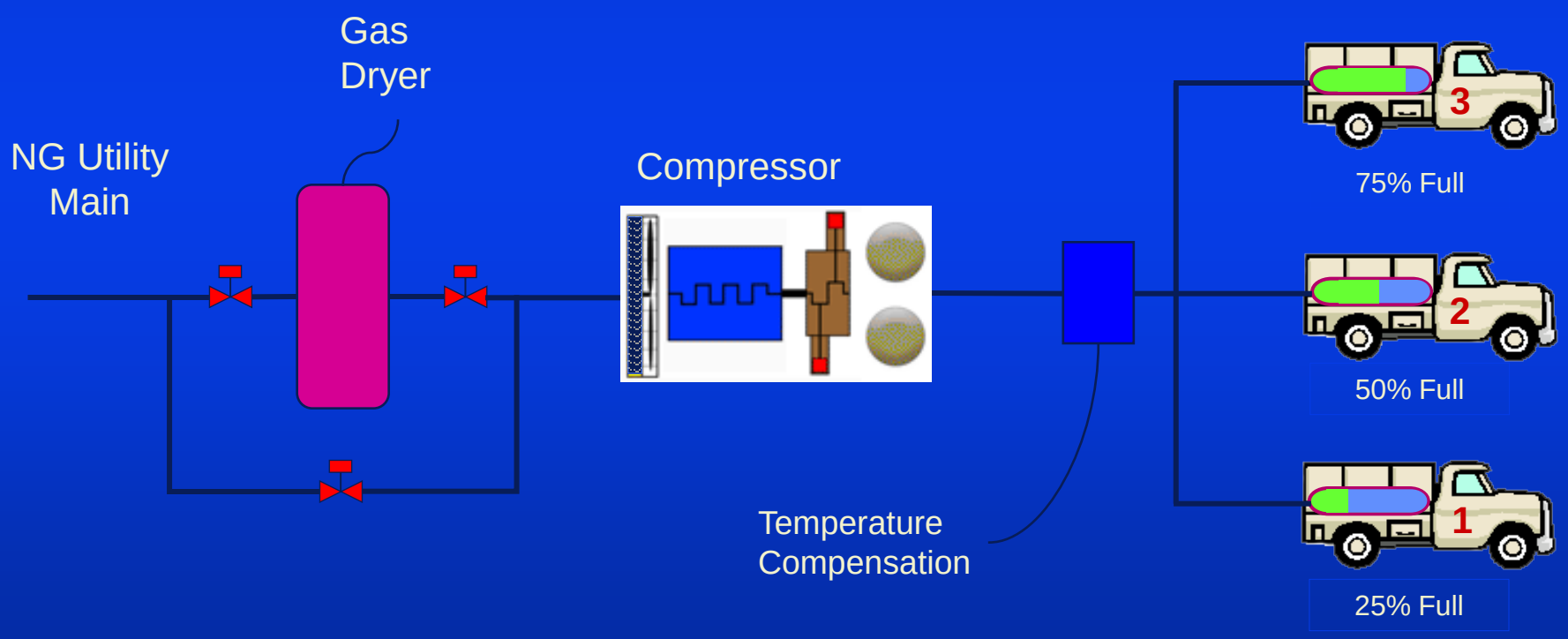
- **Time-fill capability**
  CNG is dispensed slowly directly to vehicles' onboard storage tanks. Lower cost station investment. Best for fleets that return to central lot and sit idle overnight or for extended periods and do not need fast fill capability.


- **Fast-fill capability**
  Similar to liquid fueling station, same fill rates and times. A MUST for public access. Also good for larger fleets where fueling turn-around time is short.

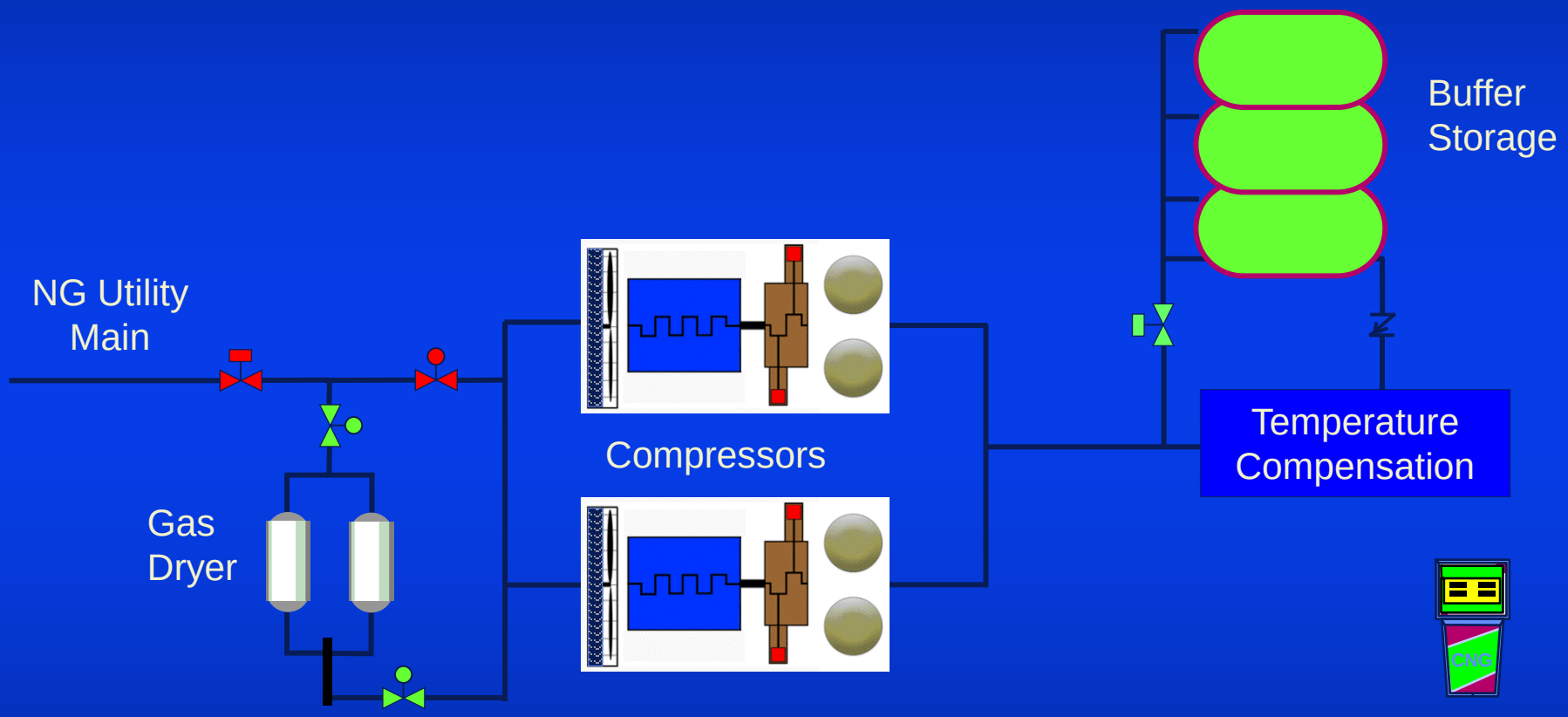

- **Combo-fill capability**
  Comprises both time-fill and fast-fill. Often good for fleets that can fuel on time-fill but need occasional "top off" or want/need ability to provide public access

# Time-Fill Fueling Station

Vehicles connect to time-fill dispensers as they return to the yard.



# Buffered Fast-Fill Fueling Station



# BUFFERED FAST FILL CNG STATIONS

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# BUFFERED FAST FILL CNG STATIONS

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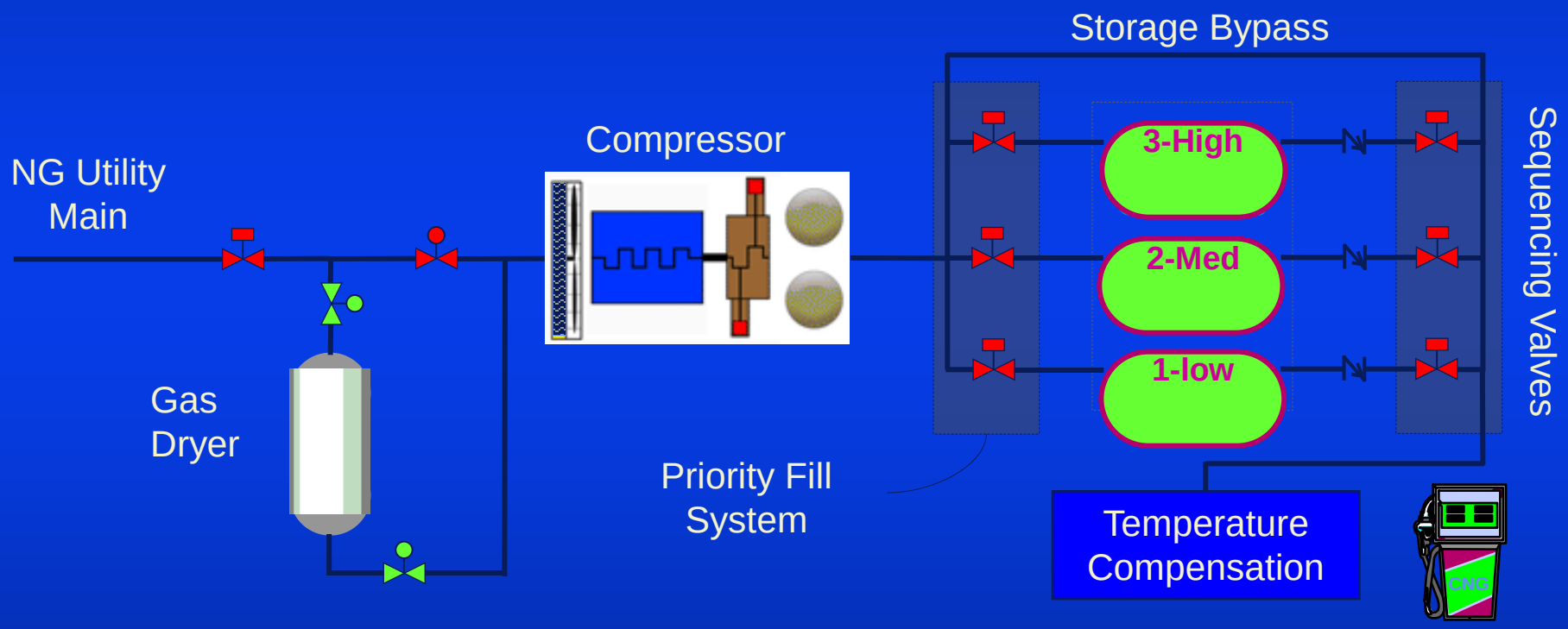
# Cascade Fast-Fill Fueling Station



# Fast-Fill Cascade System

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# TEMPORARY & PORTABLE CNG STATIONS

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# Natural Gas Fuel Station Options

- Offsite – use existing public access station
  - Station may be operated by independent retailer, utility or another fleet
  - Development usually driven by anchor fleet and/or the ability to “pool” fleets to achieve fuel use needed to warrant initial investment

- Onsite - private access (e.g., only for the fleet operator)
  - Many existing large fleets (e.g., transit, refuse) or fleets with restricted access sites (e.g., federal property such as military bases) still operate private-access-only stations. Time-fill-only stations are always private access.

- Onsite - public access (often “outside the fence” pump)
  - Growing trend: public access pump installed at fleet location - located adjacent to or “outside the fence” of fleet’s secure fueling area. Takes advantage of economies of scale, promotes greater public network.
  - Allows independent fuel provider opportunity to serve anchor with lower load while building additional load via sales to other fleets and/or consumers

# CNG Station Design Considerations

## How Much Fuel in How Much Time?

- What is the projected number of vehicles per day and what is the required fuel per vehicle?
- What are the fueling patterns?
  - Are all fueled at once?
  - Can they be staggered throughout the day?
- What is the maximum *daily* flow and maximum *hourly* flow
  - This affects equipment selection and/or storage amount, especially when designing CNG station
- If CNG station, is backup fueling available nearby (even if only on an emergency basis) or is design redundancy required?

# Station Design/Cost Considerations

Station Design/Cost Factors *other than* Fuel vs Time


- Real estate
  - Location:
    - Urban/Suburban/Rural  and cost of land
    - Competition with other commercial businesses for prime locations
    - Traffic access
  - Size of property
    - Required space for equipment footprint
    - Required space for  vehicle traffic (including # of islands, vehicle entry/exit)
  - Site Development
    - Remediation of existing fueling site
    - Permits, Codes & Regulations

# Station Design/Cost Considerations

Station Design/Cost Factors Impacted by Fuel vs. Time

- Fueling equipment needs/costs
  - Compression:
    - Electric drive or gas engine drive
      - Size of electric service?
      - Inlet gas psi and peak flow rates
    - Sizing (HP and SCFM rating) is critical
    - Enclosures for sound attenuation
    - Sophistication of controls
  - GGE/hr = 0.5 x SCFM (@ rated inlet psi)
    - Ex: 200 SCFM compressor = ~100 GGE/hr
    - Ex: 75 SCFM compressor = ~35-37 GGE/hr

# Station Design/Cost Considerations

Station Design/Cost Factors Impacted by Fuel vs Time

- Fueling equipment needs/costs
  - CNG Storage:
    - Is it needed? If so, what is balance between compression capacity and storage needs
    - Peak storage requirements and dispensing projections
    - Cascade vs buffer system
    - Type of storage containers ( Spheres or cylinders)
    - Available space

# Station Design/Cost Considerations

Station Design/Cost Factors Impacted by Fuel vs Time

- Fueling equipment needs/costs
  - Natural gas dryers:
    - Projected volume and flow rates
    - Inlet gas pressure and potential variance from spec
    - Moisture content (gas analysis) and historical variances from spec
    - Manual vs automated regeneration
    - Single tower versus dual towers

# Station Design/Cost Considerations


- Fueling Equipment Needs/Costs
  - Dispensers and Fuel Management:
    - Time fill posts? Or Fast Fill dispensers? Both?
    - Number and type to meet expected vehicle types/counts
    - Fuel metering/data capture, payment system?
    - CCs/pmt cards
    - Training verification (e.g., “first time user” video )

# Natural Gas Station Development and Ownership-Operations Options: #1

- Fleet owns & operates station
  - Fleet takes responsibility for building and then operating its own station. Fleet works with vendors or design consultant, manages build-out and takes responsibility for PM (parts, etc).
  - Applies to small-to-mid sized fleets that do not have offsite options nearby, b/c their fuel use does not meet the threshold required by most LDCs or independent developers to invest in developing, owning and operating station for them.
  - Some large fleets also opt for this but many do not have experience nor want responsibility for station operations and maintenance

# Natural Gas Station Development and Ownership-Operations Options: #2

- Outsource station development, ownership, O&M to independent fuel provider
  - Fleet serves as anchor for independent operator's station, contracts long term fuel agreement with set price(s) and expected throughput for duration.
  - One stop shop. All capital investment and O&M risks are borne by independent fuel provider while fleet focuses on core competencies.
  - Fleet usually provides low-cost lease for property – important to making deal work - land is costly!
  - Often allows fuel provider option to create public access as well – sometimes a "royalty" paid back to fleet for retail sales from premises

# Natural Gas Station Development and Ownership-Operations Options: #3

- Fleet owns/leases station but contracts out operations for a fee (e.g., monthly fee or GGE basis)
  - Option used by many large fleets that need/desire ownership of their own station equipment but want to reduce risk, assure best O&M practices, etc
  - Contract is often (but not always) awarded to the firm that builds station; usually a 5-7yr contract.
  - Some fleets that initially Own & Operate their own stations decide that they want to delegate to others – put out RFP for O&M contract
  - Decision weighs pros/cons of “leaving $ on table” versus potential downtime risks, maintaining parts inventories, updated training of techs, etc

# CNG Fuel Economics

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| CNG - FUEL COSTS WORKSHEET (CNG Replacing Gasoline) | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| Cost per MCF | $ 5.00 | Gas Commodity + Procurement (Unregulated) | | | $ 0.63 | per GGE |
| SCF per MCF | 1000 | | | | | |
| SCF per GGE | 125 | | | | | |
| GGE per MCF | 8.00 | | | | | |
| Cost per GGE | $ 0.63 | | | | | |
| | | | | | | |
| Cost per MCF | $ 1.50 | Distribution (Regulated) | | | $ 0.19 | per GGE |
| SCF per MCF | 1000 | | | | | |
| SCF per GGE | 125 | | | | | |
| GGE per MCF | 8.00 | | | | | |
| Cost per GGE | $ 0.19 | | | | | |
| | | | | | | |
| | | Electric compression costs | | | $ 0.12 | per GGE |
| | | Maintenance/Service/Repair of CNG Station | | | $ 0.30 | per GGE |
| | | Allocate Station Capital Cost to the GGE | | | $ 0.50 | per GGE |
| | | Subtotal | | | $ 1.73 | per GGE |
| | | Assumed taxes | | | $ 0.51 | |
| | | TOTAL COST OF FUEL | $ - | | $ 2.24 | per GGE |

# Putting It All Together:

# -Examples for Your Fleet Operations

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# *Key Attributes and Best Prospects*


- High fuel use vehicles with return-to-base operations or repetitive route or pre-set geographic operating areas
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- Consumer market tends to follow infrastructure*

# Vehicle Economics

| Fleet = | LTL Trucking |
|---|---|

FUEL COST TABLE

| Assumptions | UNITS | | Diesel |
|---|---|---|---|
| | | | |
| Avg Diesel Fuel Cost (including taxes) | ($/gal) | | $4.00 |
| Avg CNG GGE Cost (including taxes) | ($/GGE) | | $2.24 |

VEHICLE ANALYSIS

| | | | | | Truck |
|---|---|---|---|---|---|
| type of conversion - | | | | | CNG |
| compared to - | | | | | Diesel |
| Annual Diesel gallons used | (gal/yr) | | | | 25,000 |
| Annual CNG GGE used to replace diesel | | | | | 30,500 |
| | | | | | |
| Life-cycle (life of vehicle - years) | (yrs) | | | | 7 |
| Number of vehicles could be replaced | (#) | | | | 1 |
| Annual Fuel Cost Savings (per vehicle) | ($/yr) | | | | $31,680 |
| Annual Fuel Cost Savings (all vehicles) | ($/yr) | | | | $31,680 |
| Life-cycle Fuel Cost Savings (per vehicle) | ($/life) | | | | $221,760 |
| Life-cycle Fuel Cost Savings (all vehicles) | ($/life) | | | | $221,760 |
| | | | | | |
| CNG Premium, per vehicle | ($) | | | | $60,000 |
| QAFMV (Purchase) Tax Credit, per vehicle | ($) | | | | $0 |
| Grant Funding, per vehicle | ($) | | | | $0 |
| Transportation cost, per vehicle | ($) | | | | $0 |
| Incremental Cost to City (w/o grant funding) | ($) | | | | $60,000 |
| Incremental Cost to City (with grant funding) | ($) | | | | $60,000 |
| | | | | | |
| CNG Premium Simple Payback (w/o grant funding) | (yrs) | | | | 1.89 |
| CNG Premium Simple Payback (with grant funding) | (yrs) | | | | 1.89 |

# CNG:
# Assessing its viability for you, your fleet, or your facility

CNG Feasibility Study components:

> Technical feasibility
> Zoning, Permitting, & Fire Code requirements
> Preliminary CNG Fueling Station Design
> CNG vehicle considerations
> Building modifications (if vehicles will be fueled or repaired inside)
> Project capital costs
> ROI & Financial Feasibility
> Environmental benefits
> Operations & maintenance
> Site maps/drawings
> Grant opportunities/assistance

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